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Germination Studies of the Seeds of Some Common Weeds

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GERMINATION STUDIES OF THE SEEDS OF SOME COMMON WEEDS

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The germination of the seeds of weeds and other plants that reseed themselves is noticeably periodic. In some species the grand period of germination closely follows the rise in temperature above freezing and the thawing of the soil in the spring while in other species germination is delayed till late spring or summer, and in the case of winter annuals the seeds germinate mainly in the fall.

Some common species with seeds germinating early are the wild lettuce *(Lactuca scariola L.)*, knotweed *(Polygonum aviculare L.)*, curly dock *(Rumnex crispus L.)*, lamb's quarter *(Chenopodium album* L.), wild parsnip *(Pastinalca sativa* L.), floating foxtail *(Alopecurus geniculatus* L.), Chapman's poa *(Poa Chapmaniana,* Scribn.), wild carrot *(Daucus carota* L.), the summer cypress *(Kochia scoparia* L.), and Russian thistle *(Solsola kali,* var. *tenuifolia* G. F. W. Mey). Those species with seeds germinating later in the spring are commonly represented by the Jimson weed *(Datura stramonium* L.), sandbur *(Cenchrus Carolinianus* Walt.), cockelbur *(Xanthium canadense* L.), shoofly *(Hibiscus trionum* L.), velvet leaf or butterprint *(Abutilon theophrasti Medic.)*, barnyard grass *(Echinochloa crus-galli* (L) Beauv.), green foxtail *(Setaria viridis* (L.) Beauv.), pigeon grass *(Setaria glauca* (L.) Beauv.), whorled foxtail *(Setaria verticillata* (L.) Beauv.), pigweed or green amaranth *(Amaranthus retroflexus* L.), prostrate pigweed *(Amaranthus blitoides* (Wats)), tumble weed *(Amaranthus graecizans* L.), and crab grass *(Digitaria sanguinalis* (L.) scop.)

The mustards of which the shepherd's purse *Capsella bursa-pastoris* L.), and pepper grasses *(Lepidium apetalum* L. and *virginicum* L.), and tumble mustard *(Sisymbrium altissimum* L.) are common representatives, and the squirrel tail grass *(Sitanion hystrix* L.), and the downy brome grass *(Bromus tectorum* L.) are species with seeds of which many germinate in the fall.

The plants that get started in the fall must be exceptionally hardy in the early stages of development for they run the hazard of being killed by the winter temperatures. The species with seeds that germinate early in the season have a long period in which to develop and mature seeds but on cultivated ground they are greatly in danger of destruction in their early stages of development by the preparation of the land for crops. Those that start their growth in late spring or summer as the Amaranths, barnyard grass, and foxtails, which delay their germination until after most of the preparation of the ground for planting to crops is over have better going and commonly make a good showing in the corn and soybean fields in the fall.

The loss caused by the more common weeds, such as the foxtails and pigweeds, which are annuals but so generally prevalent on cultivated ground in the corn belt that they exact some loss from practically every type of cultivated crop, justifies an increased effort to control them. Like the weeds regarded as noxious, nearly all of the annual weeds have been introduced from other countries, many from Europe, some from Mexico and some from the tropics or elsewhere, and generally through the use of impure agricultural seed. Through neglect to prevent their seeding, cultivated soils have become thoroughly fouled with their seeds which will serve for years as sources of repeated infestations. Thus only by 100 per cent clean cultivation over a period of years, the length of the period unknown but no doubt variable for the different species, can these weeds be eliminated. Any effort, however, that reduces the infestations will pay well in better crops. The infestations are most easily destroyed in the seedling stage for which reason it is of some importance to know the germinating periods of the seeds of the different species.

Over a period of years the germination of the seeds of a number of the common weeds have been observed on some of the experimental plots at the Iowa Experiment Station at Ames and germination data recorded as shown in Table I.

TABLE I: THE DATES AT WHICH THE SEEDS OF THE DIFFERENT SPECIES WERE OBSERVED TO BEGIN GERMINATING IN THE FIELD.

SCIENTIFIC NAME	COMMON NAME	1934	1935	1936	1937	1941	1942
Amaranthus blitoides	prostrate pigweed	5–4	4–15	4–12	.....	5–10	4–10
Amaranthus graecizans	tumble weed	5–1	4–15	4–12	.....	5–10	4–10
Amaranthus retroflexus	pigweed-green amaranth	5–1	4–15	4–12	.....	5–10	4–10
Ambrosia artemisiifolia	small ragweed	.....	4–10	4–5	.....	.....	4–1
Ambrosia trifida	great ragweed	.....	4–10	4–5	.....	.....	4–1
Abutilon theophrasti	velvet leaf butter print.	5–20	5–21	5–5	5–9	6–1	5–1
Arctium lappa	great burdock	.....	4–24	4–10	4–20	.....	4–1
Alopercurus geniculatus	floating foxtail	.....	.....	.....	.....	4–1	3–28
Bromus tectorum	downy brome	8	(9) (10) (4)	.....	.....	(9) (10) (4)	.....
Capsella buraspastoris	Shepherd's purse	7–28	.....	8–20	7–16	7–11	.....
Cenchrus cariolinianus	sandbur	5–8	5–25	5–15	.....	.....	.....
Chenopodium album	lamb's quarters	4–1	4–1	3–20	.....	4–1	.....
Daucus corota	wild carrot	.....	.....	4–25	.....	(9) (10) (4)	3–30
Datura stromonium	jimson weed	.....	5–15	5–10	5–15	4–20	4–4
Echinochloa cruss-galli	barnyard grass	.....	5–15	5–10	5–14	.....	5–3
Sitanion hystrix	squirreltail grass	.....	.....	(9) (10) (4)	.....	.....	.....
Kochia scaparia	summer cypress	.....	3–1	2–28	.....	4–1	.....
Lactuca scariola	wild lettuce	3–5	3–8	3–1	.....	4–1	3–18
Pastinaca sativa	wild parsnip	4–1	4–1	3–25	.....	.....	3–22
Poa chapmaniana	Chapman's poa	.....	.....	.....	4–6	4–1	3–29
Polygonum aviculariа	knotweed	3–12	3–10	.....	.....	.....	3–17
Salsola kali var. tenuifolia	Russian thistle	.....	3–15	.....	.....	.....	3–28
Setaria glauca	foxtail pigeongrass	5–4	5–4	4–25	5–1	5–20	5–2
Setaria viridis	green foxtail	5–4	5–4	4–25	5–1	5–20	5–2
Setaria verticillata	whorled foxtail	5–4	5–4	4–25	5–1	5–20	5–2
Solanum rostratum	buffalo bur	.....	5–25	5–15	5–15	5–20	5–4
Verbena hastata	blue vervain	4–5	4–1	4–10	.....	.....	5–1
Xanthium canadense	Cocklebur	.....	.....	.....	5–1	5–2	4–22
Rumex crispus	Curly dock	.....	4–1	3–25	.....	4–10	4–5
Hibiscus tarionum	shoofly	.....	.....	.....	5–9	5–15	5–5
Digitaria sanguinalis	crab grass	.....	.....	5–15	.....	5–20	5–15
Rumex acetosella	Red sorrel	.....	.....	.....	.....	4–10	3–28
Sonchus arvensis	corn sow thistle	.....	.....	.....	.....	4–1	4–2
Bromus secalinus	chess	.....	7–24 Oct.	.....	.....	Sept. Oct. April	.....
Bragrostis cilianensis	stink grass	.....	.....	5–26	.....	5–20	.....
Sisymbrium officinalis	tumble mustard	4–15	.....	.....	4–4	4–1	.....

As shown in Table I, the germinating period of the early germinating seeds varies considerably with the conditions for growth of the different seasons.

The data in Table I pertain only to the initiatory stage of the germination period which is widely variable in length for the different species. Species with very short periods of seed germination are represented by Chapman's poa and floating foxtail. The germination period of their seeds is pretty well restricted to March and April. Similarly the germinating period of the seeds of the lamb's quarter, ragweed's, wild parsnip, curly dock, and wild lettuce end

TABLE II: GERMINATION OF SOME WEED SEEDS AT DIFFERENT TEMPERATURES WITH SEED COATS INTACT AND PARTIALLY OR WHOLLY REMOVED. TEST MADE SOON AFTER HARVEST.

Species	Seeds untreated — Germination at—					Seed coat entirely or partially removed — Germination at—				
	15°	20°	25°	30°	35°	15°	20°	25°	30°	35°
Abutilon (range) *theophrasti* (velvet leaf) (Av.)....	4–26 15	10–28 18	12–22 18	8–20 14	10–36 25				62–76 69	
Amaranthus blitoides..... (creeping pigweed)			0					33		
Amaranthus graecizans (tumble weed)	0	0–2 1	2–24 11	0–60 27	48–84 59	18–38 28	17–58 38	57–88 76	30–88 64	59–96 78
Abrosia artemisiifolia (small ragweed)	0	0 0	0	0	0	14	14	46	47	48
Ambrosia trifida (large ragweed)	0	0	0	0	0	2	20	60	64	55
Chenopodium album (lamb's quarter)	10–20 17–	18–35 24	16–64 28	10–60 23	4–34 19	70–95 82	92–96 94	96–98 97	96–98 97	94–100 97
Daucus carota (wild carrot)	26–30 28	48–58 53	28–78 59	24–86 55	0–76 53					
Datura stromonium (jimson weed)			33					100		
Digitaria sanguinalis (crab grass)		0	2	0–18 8	12–24 18	8	27	29	29	37
Echinochloa crus-galli (barnyard grass)			0					50		
Hibiscus trionum (shoofly)	8	8–10 9	4–15 12	4–19 12	4–8 7				46–80 63	
Panicum capillare (witch grass)			2–8 5	0–92 39	42–97 89			32–84 56	32–80 52	48–52 50
Setaria viridis (green foxtail)			14–53 28	20–55 34	34–58 49	63	71	40–86 70	64–90	68–74

rather abruptly with the approach of summer temperatures. The germination of the foxtails, crabgrass, stinkgrass, cocklebur, buffalo bur, sandbur and jimson weed is confined mostly to May and June. In some species, as for example the wild carrot, the seeds germinate at various times in the season, especially during the spring and the fall.

As shown in Table II some investigations were made to determine the relation of the seed and fruit coverings and temperature to the germination of the seeds of some common weed species.

In all species except the wild carrot, the seed coat appears to be a limiting factor in the germination of the seeds. In a number of cases high temperatures tended to increase the permeability of the seed coat. The temperatures most favorable for germination in most instances ranged 20 to 30°C., either 25° or 30° being most favorable for the grasses, amaranth, velvet leaf, and jimson weed seeds, which are representative of late spring germinating species. The seeds of the wild carrot and lamb's quarter which have an early germinating period germinate at relative low temperatures.

The seeds of some of the species were investigated as to their germination after storage in a constantly low temperature, both in a dry and wet condition. As shown in Table III the seeds of most of the species do not require an exposure to alternating temperatures for good germination, but germinate well after a storage at a low constant temperature and whether kept constantly wet or constantly dry.

Table III: The percentage of germination of seeds after being stored over winter in a constantly low temperature of 5°C. The seeds were harvested before frost and stored in refrigerators until time of germination tests in early June. One lot was kept wet and the other dry.

Scientific Name	Common Name	Percentage Germination	
		Dry	Wet
Abutilon theophrasti	velvet weed	95	92
Amaranthus blitoides	prostrate amaranth	0	0
Amaranthus graecizans	tumble weed	60	65
Amaranthus retroflexus	pigweed	88	84
Daucus carota	wild carrot	85	87
Digitaria sanguinalis	crab grass	2	5
Hibiscus trionum	Shoofly (Cat's eye)	24	10
Lactuca scariola	wild lettuce	98	94
Lepidium apetalum	pepper grass	90	89
Melilotus alba	white sweet clover	14	85
Pastinaca sativa	wild parsnip	90	95
Rumex crispus	curly dock	96	93
Setaria glauca	smooth foxtail	92	90
Setaria viridis	green foxtail	98	95
Solanum carolinense	horse nettle	0	3
Verbena hastata	blue vervain	0	2

TABLE IV: GERMINATION OF WEED SEEDS COLLECTED, AND STORED UNDER DIFFERENT CONDITIONS.

Date of Germination Tests and Species	Stored 14°		Stored Laboratory Temp.	Stored outdoors in cheesecloth bags	
	Dry percent Germ.	Wet percent Germ.	Dry percent Germ.	Dry percent Germ.	Wet percent Germ.
Abutilon theophrasti (Velvet leaf)					
October, 1934	.....	.....	7	.....	.....
January, 1935	95	62	1	53	54
February, 1935	12	16	0	42	38
March, 1935	64	40	0	56	44
April, 1935	10	11	0	10	19
May, 1935	0	0	0	6	9
June, 1935	95	93	0	96	90
Amaranthus blitoides (creeping pigweed)					
October, 1934	.....	.....	20	.....	.....
January, 1935	0	1	32	0	1
February, 1935	0	0	0	0	(bottles)53
March, 1935	0	8	0	0	0
April, 1935	2	4	0	9	10
May, 1935	4	5	4	14	18
June, 1935	90	86	0	0	2
Amaranthus graecizans (tumbleweed)					
January, 1935	58	21	70	71	50
February, 1935	13	30	6	2	7
March, 1935	8	16	4	12	0
April, 1935	0	0	0	0	4
May, 1935	12	20	0	0	0
June, 1935	60	65	0	0	0
Amaranthus retroflexus (pigweed)					
January, 1935	31	1	16	41	1
February, 1935	5	4	10	8	0
March, 1935	56	4	11	72	0
April, 1935	4	0	6	4	1
May, 1935	0	0	8	0	0
June, 1935	88	84	10	20	0
Chenopodium album (Lamb's quarters)					
October, 1934	8	5	6	6	7
November, 1934	3	1	6	4	2
December, 1934	0	0	8	3	4
January, 1935	0	0	0	7	0
February, 1935	2	4	0	2	3
March, 1935	9	10	2	6	8
April, 1935	11	13	1	10	14
May, 1935	7	4	0	6	9
June, 1935	0	0	0	3	5
Daucus carota (Wild Carrot)					
October, 1934	.....	.....	71	.....	.....
January, 1935	46	78	65	79	31
February, 1935	40	39	25	32	37
March, 1935	52	72	0	16	7
April, 1935	9	10	0	0	0
May, 1935	0	0	0	0	0
June, 1935	85	88	0	62	66

TABLE IV: GERMINATION OF WEED SEEDS COLLECTED, AND STORED UNDER DIFFERENT CONDITIONS—Continued

Date of Germination Tests and Species	Stored 14°		Stored Laboratory Temp.	Stored outdoors in cheesecloth bags	
	Dry percent Germ.	Wet percent Germ.	Dry percent Germ.	Dry percent Germ.	Wet percent Germ.
Digitaria sanguinalis (goosegrass)					
January, 1935	1	0	2	0	0
February, 1935	22	7	0	1	0
March, 1935	44	68	1	4	0
April, 1935	4	0	0	0	0
May, 1935	8	4	0	0	0
June, 1935	2	5	0	0	0
Hibiscus trionum (shoofly)					
November, 1934			2		
December, 1934			10		
January, 1935	1	0	2	0	0
February, 1935	3	0	0	2	6
March, 1935	16	0	1	8	0
April, 1935	4	0	0	0	0
May, 1935	2	0	0	0	0
June, 1935	24	10	0	2	0
Lactuca scariola (wild lettuce)					
August, 1935					
January, 1935	74	75	45	45	41
February, 1935	0	0	34	4	5
March, 1935	14	0	12	24	24
April, 1935	0	0	4	8	16
May, 1935	0	0	0	0	12
June, 1935	98	94	2	90	88
Lepidium apetalum (pepper grass)					
December, 1934			26		
January, 1935	49	72	21	78	36
February, 1935	7	0	0	8	4
March, 1935	36	0	0	16	2
April, 1935	26	20	0	0	0
May, 1935	32	20	0	0	0
June, 1935	90	89	0	98	96
Pastinaca sativa (wild parsnip)					
At collection			7		
January, 1935	9	20	38	0	0
February, 1935	0	0	26	0	0
March, 1935	0	60	12	8	4
April, 1935	0	0	0	12	8
May, 1935	0	0	5	0	0
June, 1935	0	0	0	0	0
Rumex crispus (curly dock)					
October, 1934			60		
January, 1935	76	81	2	61	30
February, 1935	0	1	0	9	15
March, 1935	32	36	0	68	36
April, 1935	6	1	0	0	1
May, 1935	1	0	0	0	0
June, 1935	96	92	0	95	90

TABLE IV: GERMINATION OF WEED SEEDS COLLECTED, AND STORED UNDER DIFFERENT CONDITIONS—Continued

Date of Germination Tests and Species	Stored 14°		Stored Laboratory Temp.	Stored outdoors in cheesecloth bags	
	Dry percent Germ.	Wet percent Germ.	Dry percent Germ.	Dry percent Germ.	Wet percent Germ.
Setaria glauca (foxtail)					
October, 1935	.....	.....	.....	.....	2
January, 1935	9	10	16	24	36
February, 1935	.....	.....	.....	.....	45
February, 1935	.....	.....	.....	.....	5
Setaria viridis (green foxtail)					
October, 1934	.....	.....	2	.....	.....
October, 1934	.....	.....	12	.....	.....
January, 1935	69	81	50	22	28
February, 1935	35	46	4	2	3
March, 1935	9	22	0	88	24
April, 1935	10	6	0	6	10
May, 1935	0	0	0	0	0
June, 1935	98	95	98	99	96
Sisymbrium officinale (tumble mustard)					
January, 1935	19	12	28	14	14
February, 1935	10	11	0	11	8
March, 1935	13	9	9	18	16
April, 1935	9	4	10	13	16
May, 1935	0	1	0	7	5
June, 1935	3	0	0	0	4
Solanum carolini ense (horse nettle)					
January, 1935	0	3	18	0	0
February, 1935	0	7	0	0	1
March, 1935	0	0	0	0	0
April, 1935	0	0	0	0	0
May, 1935	0	0	0	0	0
June, 1935	0	0	0	0	0
Verbena hastata (blue vervain)					
January, 1935	0	25	12	0	5
February, 1935	0	3	7	0	2
March, 1935	0	12	3	0	12
April, 1935	0	0	0	0	0
May, 1935	0	0	0	0	0
June, 1935	0	2	1	0	0

The seeds of *Rumex crispus*, *Pastinaca sativa*, *Daucus carota*, and *Melilotus alba* in the wet samples, all early germinating species, germinated in the refrigerator before they were removed for the tests. Unlike the seeds of many cultivated plants, most of the weed seeds included in the Table III and IV apparently suffer very little if any impairment of vitality by being kept constantly wet at low temperatures. In Table IV are shown the germinations of some common weed seeds after different periods of storage under both constant and fluctuation temperatures.

The results given in Table IV again emphasize the fact that most of seeds included have no specific requirements for germination. The seeds of the velvet leaf, amaranths, wild carrot, wild lettuce, pepper grass, curly dock, and green foxtail, germinated about equally under the three types of storage. In case of the seeds of the velvet leaf, amaranths, curly dock, and green foxtail, the germinations were better at the end of the storage period in June, but in most cases the germination was fair after short periods of storage. The seeds of green foxtail, curly dock, pepper grass, velvet leaf, wild lettuce, wild carrot, and tumble weed apparently would germinate in the field during the winter months if their required germination temperatures were provided.

The seeds of the horse nettle and blue vervain are restricted in germination by requirements that were not met in any of the tests and no satisfactory germination was obtained.

SUMMARY

The seeds of the common weeds discussed in this paper are periodical in germination, some species germinating early in the spring, others in late spring or early summer, and some in the fall. Some of the early germinating species germinated in moist storage at 5°C. The seeds of all species investigated, excepting those of the horse nettle and blue vervain, require no special conditions for germination beyond suitable moisture and temperature. In most cases germination is somewhat inhibited by seed coat or fruit covering until after a short period of weathering. Various types of storage, as in constantly low, laboratory, or alternating outdoor temperatures, did not as a rule affect significantly the germination, which was good after all types of storage.

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